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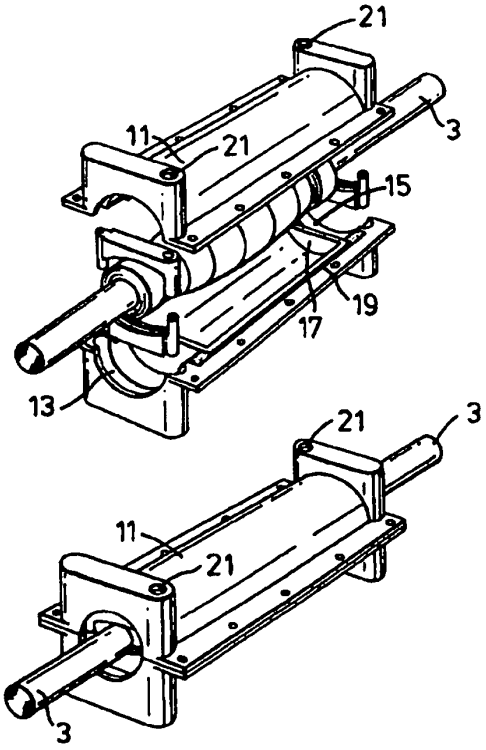
(54) Title: CABLE SPLICE CLOSURE

(57) Abstract

A cable splice closure comprises a casing (11) which can be closed around a cable splice (1), and one or more cable grippers (7) which can be operated from the exterior of the casing (11). The or each cable gripper (7) preferably comprises one or more jaws (9) which can be moved with respect to the casing (11) to grip a cable (3), by means of one or more screw-threaded bolts or the like extending out of the casing. This allows the closure to be closed around a splice before it is tightly secured to the cables, thus permitting adjustments to the position of the closure with respect to the cables after it has been closed around the splice.



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Cable Splice Closure

The present invention relates to a cable splice closure and to a cable gripper, for example for telecommunications or electrical cables. Although the invention is particularly applicable to the splicing and gripping of cables (including copper wire cables, optical fibre cables, wires, and optical fibres), at least some embodiments of the invention may be applicable to the splicing and gripping of pipes (especially district heating pipes) or other elongate objects. Hence, even though the specification refers throughout to cables, it is to be understood that pipes or other elongate objects may, at least in some embodiments of the invention, be substituted for cables, and consequently that the invention may comprise a pipe splice closure and a pipe gripper.

Many different types of cable splice closure are known. For example, United States Patent No. 4295005 discloses a telecommunications cable splice closure comprising a pair of elongated covers having semi-cylindrical interior walls extending radially about a closure axis. The closure includes a pair of clamp brackets which are each formed with a set of four radial slots into which metallic, L-shaped, toothed clamping elements are slidably retained. To enclose a cable splice, a band of compressible mastic type sealant is placed about the cable within end ports of one of the semi-cylindrical covers of the closure, between two washers seated in grooves. The toothed clamping elements of each clamp bracket located in the cover are then slid radially inwardly into gripping engagement with the cable. The other semi-cylindrical cover is then placed over the splice area and the two covers are fastened together.

United States Patent No. 4341922 discloses a strain-relief device for use in a cable splice case for communications cables, comprising two or more braces which are strapped to each cable end inside the splice case. The braces grip the cable with extended tangs and are held firmly in place by a hose clamp which passes around the cable and through openings in the braces. In order to enclose a cable splice in the splice case, a bottom half-shell is supported in place beneath the splice area to assist in

properly locating cable collars around the cables. Mastic tape is convolutely wound around each cable, washers are placed over the cable ends and against both sides of each tape winding, and the cable collars are applied around the mastic tape windings around the cables. After the strain relief fittings have been added, the two halves of the outer shell are assembled over the whole.

European patent application no. 0316911 discloses a cable closure for closing a junction point of two cables, comprising a sleeve, a pair of rigid end plates for closing the spaces between the cables and the sleeve, an elastic tape wound around the cables for sealing any gaps between the cables and the rigid end plates, and an elastic tape wound around each rigid end plate for sealing any gaps between the end plates and the sleeve. In order to secure the cables to the sleeve, each cable is gripped by means of an annular screw support member which is itself attached to one of the rigid end plates inside the sleeve. Three fastening screws having arcuate cable push members are screwed into holes in the circumference of each annular screw support member, and these screws are screwed radially inwards towards the cable in order to grip the cable. After having fastened the screws of the annular support member to the cables (thereby fastening the cables to the rigid end plates), the sleeve is closed around the assembly.

All of the above cable splice closures are quite complex in construction, containing a large number of parts which have to be assembled together in order to secure the spliced cables to the closure and to ensure that the closure is sealed. Consequently, installation of such cable splice closures around a cable splice is often time-consuming and normally requires a high degree of skill and training on the part of the installation engineer.

The object of the present invention is to solve the problems associated with the above known cable splice closures, i.e. to provide a cable splice closure which is easy to install around a cable splice, which is simple in construction, and which has only a small number of discrete components while ensuring that it is inexpensive to

manufacture, that it provides good environmental sealing, and that it substantially prevents forces, particularly axial forces, which may act on the cables, from damaging a splice enclosed by the closure.

According to a first aspect of the invention, there is a cable splice closure, comprising:

(a) a casing which can be closed around a cable splice; and

(b) one or more cable grippers which can be operated from the exterior of the casing.

Preferably, the or each cable gripper comprises at least one jaw which, in order to grip a cable extending, in use, into the casing, can be moved with respect to the casing by means of tightening means which can be operated from the exterior of the casing when the casing is closed in use. Preferably, the or each cable gripper is situated inside the casing when the casing is closed in use. Preferably, the or each tightening means locates at least one said cable gripper, preferably in a floating manner, inside the casing. The or each jaw can preferably be moved, by means of at least one said tightening means, with respect to the casing in a direction substantially transverse to the cable.

The invention has the advantage that because the or each cable gripper can be operated from the exterior of the casing, the cable gripper(s) normally do not need to be tightened around the cable(s) until the casing is at least partially closed around the splice. This is advantageous because it can make the installation of the splice closure easier than with the known closures described above, since it is normally not necessary for the installation engineer to secure the cable gripper(s) to the cable(s) at exactly the correct position before closing the casing. The cable gripper(s) will normally be automatically positioned correctly on the cable(s) when the casing is closed, and then may simply be tightened around the cables by means of the tightening means(s) from the exterior of the casing. In contrast, with the known closures above it is necessary for the installation engineer to secure the cable grippers

tightly to the cables at exactly the correct positions (in order, for example, for the grippers to fit properly within the casing) before closing the casing around the splice. This makes the installation 'craft sensitive' (i.e. requiring skill, training and accuracy), and if the installation engineer is not very careful, the closure might not perform to the required standard (e.g. it might leak and/or provide insufficient strain relief for the cables).

According to a second aspect of the invention, there is provide a cable splice closure, comprising:

(a) a casing which comprises first and second parts which can be brought together to close the casing around a cable splice;

(b) one or more cable grippers; and

(c) tightening means which, in use, at least contribute(s) to bringing together, and preferably to fastening together, the first and second casing parts, and which cause(s) the or each cable gripper to grip a cable extending, in use, into the casing, preferably as the first and second parts are brought together.

The second aspect of the invention (and preferably also the first aspect of the invention) has the advantage that because the tightening means cause(s) the or each cable gripper to grip a cable extending into the casing and at least contribute(s) to bringing together, and preferably to fastening together, the first and second casing parts, the splice closure is particularly simple to install.

It is to be understood that any or all of the preferred features of the invention described herein may advantageously be present in any or all of the aspects of the invention.

The or each cable gripper preferably comprises two jaws between which a cable can be gripped, and which can preferably be moved with respect to each other in a direction substantially transverse, preferably substantially perpendicular, to the cable when, in use, it extends into the casing.

Advantageously, in preferred embodiments the movement of the or each jaw with respect to the casing in order to grip a cable comprises pulling the or each jaw towards the cable. According to preferred embodiments of the invention therefore, in order to grip a cable extending into the closure, the or each jaw of the or each cable gripper may be pulled towards the cable, preferably by means of at least one said tightening means. Cable splice closures according to the invention which function in this way can have a particularly simple yet effective construction. Preferably, the or each cable gripper comprises two jaws which can be pulled towards each other to grip a cable therebetween.

The invention can preferably have the advantage that pulling the jaws towards the cable(s) may cause the casing to be closed. Gripping the cable(s) with the jaws may simultaneously close the casing. For example, the casing may advantageously be formed as two parts, e.g. two half-shells (which may initially at least be separate or may be pre-connected or integrally joined), the casing being closed in use by joining together one or more opposing longitudinally extending edges of the half-shells. It will be appreciated that if the or each cable gripper comprises two jaws, each of which may be pulled towards a cable by means of tightening means (preferably operable from the exterior of the casing), the effect of tightening both jaws about the cable by pulling them towards the cable will be to pull the two half-shells together. If, for example, the splice closure has one or more cable grippers at each end of the casing, such a closure will be provided with a simple means of closing the casing.

The or each tightening means is preferably elongate, and preferably also extends from the interior to the exterior of the casing (especially in embodiments in which the cable gripper(s) are located inside the casing). In some embodiments, the or each tightening means is preferably flexible and may, for example, comprise cord, rope, string, wire or the like. Preferably, however, the or each tightening means is substantially rigid. The or each tightening means may advantageously be screw

threaded (e.g. it may be in the form of a screw or bolt or the like). The tightening means and/or a nut threaded onto the tightening means, may preferably be screwed, from the exterior of the casing, with respect to the casing in order to move a jaw of a cable gripper with respect to the casing. (By the term "nut" is meant a nut or like device which may be screwed along a screw threaded elongate article.)

Advantageously, the cable splice closure, especially the casing, may include guiding means which guides the transverse movement of the or each jaw with respect to the casing. Preferably, the or each cable gripper is located, in use, in a slot, and the movement of the or each jaw with respect to the casing is guided by the slot. More preferably, the slot is integral with the casing. Alternatively or additionally, a slot in the cable gripper may slide on a rail or the like on the casing, and/or jaws of a cable gripper can be slidably connected to one another and/or the halves of a casing can be slidably connected to one another.

Accordingly, a third aspect of the invention provides a cable splice closure comprising a casing which can be closed around a cable splice, and one or more cable grippers, the or each cable gripper comprising at least one jaw which, in order to grip a cable extending, in use, into the casing, can be moved with respect to the casing in a direction substantially transverse, preferably substantially perpendicular, to the cable, the or each jaw being movable in guiding means of, and preferably integral with, the casing (for example resulting merely from the shape in which the casing is formed, e.g. by stamping, moulding etc.) and which guide(s) the said transverse movement of the or each jaw. Preferably the or each guiding means comprises a slot. Alternatively or additionally, a slot in the cable gripper may slide on a rail or the like on the casing, and/or jaws of a cable gripper can be slidably connected to one another and/or the halves of a casing can be slidably connected to one another. Preferably the or each jaw can be moved by means of tightening means. More preferably, the tightening means can be operated from the exterior of the casing when the casing is closed in use.

This aspect of the invention can have the advantage that, especially when the or each guiding means, e.g. slot, is integral with the casing, the splice closure can have a particularly simple construction, and generally avoids the necessity for complex parts to be attached to the casing for locating and/or guiding the jaws, as is the case with the closures described in US 4341922 and US 4295005.

The casing (according to all aspects of the invention described herein) may, for example, be formed from metal (e.g. Aluminium) and/or a plastics material (e.g. polypropylene or polyethylene, especially ultra-high molecular weight polyethylene). When the casing is made from a plastics material, it may advantageously be moulded, e.g. blow-moulded. This is particularly advantageous for embodiments which have one or more slots for the jaw(s) which are integral with the casing, since the slot(s) can normally be moulded as part of the casing.

In preferred embodiments of all aspects of the invention, the casing may be opened along its length, to permit so-called "side-entry" of spliced cables into the casing. The casing may conveniently be of so-called wraparound configuration (which term includes the use of half or multi-shell and generally clam-shell like constructions), for example having a longitudinal split which may be opened out to permit side-entry of spliced cables and subsequently closed to enclose the spliced cables in the casing. Even more preferably, the casing may comprise two or more separable parts which may be separated to permit spliced cables to be inserted into the casing, and subsequently re-assembled to close the casing. A particularly preferred form of casing comprises two half-shells which are separable in a longitudinal (with respect to the spliced cables) direction. Opposing edges of the casing may generally be fastened together (preferably releasably) by any suitable means, e.g. one or more bolts or screws or the like and/or one or more clasps or the like and/or one or more elongate fastening members which may extend along at least part of the length of the casing (e.g. one or more rods or like member(s) extending through one or more cooperating parts of the casing, or one or more channel member(s) extending around one or more rails or flanges of the casing).

In all aspects of the invention, the casing preferably contains sealing material, at least in use. The sealing material preferably forms a seal between the casing and the or each cable extending into the casing in use and/or forms a seal between opposing parts, e.g. opposing edges, of the casing. Advantageously, the casing may have at least one sealing material containment cavity. Preferably, the or each cavity is bounded, at least in use, at one of its longitudinal extremities by a transverse wall within the casing and at the other of its longitudinal extremities by the, or at least one of the, cable grippers, or at each of its longitudinal extremities by the cable grippers (i.e. substantially the whole casing between the grippers could be filled with a sealing material).

Accordingly, a fourth aspect of the invention provides a cable splice closure, comprising a casing which can be closed around a cable splice, and one or more cable grippers, the casing having a sealing material containment cavity, to contain sealing material which forms a seal, in use, between the casing and one or more cables extending longitudinally into the casing or otherwise forms a seal around a cable splice within the casing, the or each cavity being bounded, at least in use, at one of its longitudinal extremities by a transverse wall within the casing and at the other of its longitudinal extremities by the, or at least one of the, cable grippers. This aspect of the invention has the advantage of simplicity, since it generally avoids the necessity for elaborate sealing devices, e.g. sealing devices having end plates to contain sealing material therebetween. With this aspect of the invention, sealing material may advantageously be placed directly in the or each containment cavity in the casing, preferably without the need for additional containment means for the sealing material. A particularly preferred way of providing sealing material in the casing in use is to wrap one or more strips of sealing material around the cable(s) prior to their insertion into the casing.

With regard to the fourth aspect of the invention, the or each cable gripper preferably comprises at least one jaw which, in order to grip a cable extending, in use,

into the casing, can be moved with respect to the casing in a direction substantially transverse, preferably substantially perpendicular, to the cable. The or each jaw is preferably movable by means of an tightening means. Preferably the tightening means can be operated from the exterior of the casing when the casing is closed in use. Advantageously, the closure, especially the casing, may include guiding means which guide(s) the said transverse movement of the or each jaw. Preferably, the or each guiding means comprises a slot. Desirably, the or each guiding means may be integral with the casing.

In preferred embodiments of the invention, the or each jaw has a tightening means (e.g. a screw-threaded bolt) at each transverse (with respect to the direction of extension of the cable(s)) end thereof. A particularly preferred embodiment is one in which each of two jaws may be moved with respect to the casing (and with respect to one or more cables extending into the casing) by means of one of two tightening means. For example, each tightening means may be used to pull its respective jaw towards the other jaw, thereby gripping one or more cables between the jaws. In addition to, or preferably instead of, the tightening means being arranged at each transverse end of the jaw(s), the tightening means may be arranged in one or more generally central (in the transverse direction) position(s) of the jaw(s). A particularly preferred embodiment of this type of arrangement is one in which each of the two jaws may be moved with respect to the casing by means of one of two tightening means arranged generally centrally (in a transverse direction) with respect to the jaws, and spaced apart from each other in the longitudinal (with respect to the direction of extension of the cables) direction. When the two tightening means are at substantially the same transverse position, this has the advantage of reducing the proportion of the cross-sectional area of the splice closure which is taken up by the tightening means, (thereby, for example, enabling the diameter of the closure to be reduced), in comparison with arrangements in which a tightening means is located at each transverse end of the jaws.

In embodiments in which the or each cable is gripped, in use, between a pair of jaws, there may advantageously be provided one or more intervening jaw pieces between the two jaws. In this way, a greater number of cables may normally be accommodated, since each intervening jaw piece effectively adds another pair of jaws (one intervening jaw piece converts the jaws to a "double sandwich" arrangement effectively comprising two pairs of jaws, and two intervening jaw pieces convert the jaws to a "triple sandwich" arrangement effectively comprising three pairs of jaws).

In particularly preferred embodiments of the invention, at least part of the or each jaw of the or each cable gripper may automatically adopt an optimum orientation, with respect to one or more cable(s), when the jaw is moved into the gripping contact with the cable(s) in use. Advantageously, the or each jaw or at least part thereof, may be pivoted with respect to the other jaw(s) and/or with respect to the remainder of that jaw, and the pivoted jaw or part may automatically pivot to adopt the optimum orientation for gripping the cable(s) when the jaw is moved into gripping contact with one or more cables(s) in use. For example, it is particularly preferred in embodiments in which the tightening means is/are generally centrally arranged (in the transverse direction) with respect to the jaw(s) that the or each jaw may pivot about the point of contact between the tightening means and the jaw. For example, the or each tightening means may extend through a longitudinally arranged pin or the like which itself extends through a respective jaw and about which the jaw may pivot. Additionally or alternatively, the or each jaw may have one or more part(s) which can be attached thereto or removed therefrom in order to select a particular jaw configuration corresponding to the number and/or arrangement of cables to be gripped. The part(s) may be shaped to conform to the size and/or number, of cables, for example.

According to a fifth aspect of the invention, there is provided a cable gripper, comprising at least one jaw, preferably two jaws, which can be moved into gripping contact with one or more cables, the jaw, or at least one of the jaws, having a part which, when the jaw is moved into gripping contact with one or more cable(s) in use,

automatically adopts an optimum orientation, with respect to one or more cables, for gripping the cable(s). Advantageously, part of the or each jaw may be pivoted with respect to the remainder of the jaw, and the pivoted part may automatically pivot to adopt the optimum orientation for gripping the cable(s) when the jaw is moved into gripping contact with one or more cables(s) in use. Additionally or alternatively, the or each jaw may have one or more part(s) which can be attached thereto or removed therefrom in order to select a particular jaw configuration corresponding to the number and/or arrangement of cables to be gripped. The part(s) may be shaped to conform to the size and/or number, of cables, for example.

It was mentioned above that preferred embodiments of the invention contain, at least in use, sealing material. The sealing material used in the invention may generally comprise any suitable sealing material. One preferred form of sealing material comprises a mastic, most preferably having a high compression set and minimum creep properties. The mastic preferably comprises one or more substantially non-crystalline materials, e.g. bituminous materials, elastomeric materials, and/or thermoplastic polymers. The mastic may contain one or more fillers or other additives. Examples of mastics which can generally be used as the sealing material of the present invention are disclosed in US patents 3243211, 3297819, 3396460 and 4206786. The entire disclosure of each of these patents is incorporated herein by reference. An advantageous property of mastic is that during the formation of a seal, it is normally deformable and generally able to flow easily, but after some time it is normally stable, and may have a high mechanical strength. Preferably the mastic has a softening point (when measured according to ASTM E28) of about 130°C, and when subjected to a rolling drum peel test at 23°C (according to test QAPK 027) preferably has a peel strength of abut 130N/25mm. A preferred mastic has a sheer strength (when tested according to ISO4587) of greater than 160N preferably greater than 250N. Mastics preferred for this invention have high, generally 100%, compression set.

The sealing material may additionally or alternatively comprise gel. The gel may, for example, comprise silicone gel, urea gel, urethane gel, thermoplastic gel, or any suitable gel or gelloid sealing material. Preferred gels comprise an oil - extended polymer composition. Preferably the gel has a hardness at room temperature as determined using a Stevens-Volland Texture Analyser of greater than 45g, particularly greater than 50g, especially greater than 55g, e.g. between 55g and 60g. It preferably has a stress-relaxation of less than 12%, particularly less than 10% and especially less than 8%. Ultimate elongation, also at room temperature, is preferably greater than 600%, especially greater than 1000%, particularly greater than 1400%, as determined according to ASTM D638. Tensile modulus at 100% strain is preferably at least 1.8 Mpa more preferably at least 2.2 Mpa. In general compression set will be less than 35%, especially less than 25%. Preferably, the gel has a cone penetration as measured by ASTM D217 of at least 50 (10^{-1}mm), more preferably at least 100 (10^{-1} mm), even more preferably at least 200 (10^{-1}mm) and preferably no greater than 400 (10^{-1}mm), especially no greater than 350 (10^{-1}mm). The polymer composition of the gel may for example comprise an elastomer, or a block copolymer having relatively hard blocks and relatively elastomeric blocks. Examples of such copolymers include styrene-diene block copolymers, for example styrene-butadiene or styrene-isoprene diblock or triblock copolymers as disclosed in international patent publication number WO88/00603. Preferably, however, the polymer composition comprises one or more styrene-ethylene-propylene-styrene block copolymers, for example as sold under the Trade Mark 'Septon' by Kuraray of Japan. The extender liquids employed in the gel preferably comprise oils. The oils may be hydrocarbon oils, for example paraffinic or naphthenic oils, synthectic oils for example polybutene or polypropene oils, and mixtures thereof. The preferred oils are mixtures of non-aromatic paraffins and naphthenic hydrocarbon oils. The gel may contain additives, e.g. such as moisture scavengers (e.g. Benzoyl chloride), antioxidants, pigments and fungicides.

Examples of other sealing materials which may be used with advantage include elastomeric materials, e.g. natural or synthetic rubber, adhesives, especially pressure sensitive adhesives, and grease, e.g. silicone grease.

In summary, the cable splice closure according to the invention comprises a casing which can be closed around a cable splice, and one or more cable grippers. Preferably the or each cable gripper comprises at least one jaw, preferably two jaws, which, in order to grip a cable extending, in use, into the casing, can be moved, preferably pulled, with respect to the casing in a direction substantially transverse, preferably substantially perpendicular, to the cable. The or each jaw can preferably be moved by means of tightening means which is preferably operable from the exterior of the casing when the casing is closed in use. The or each tightening means is preferably a substantially rigid elongate device which may advantageously be threaded. The tightening means(s) may cooperate with a nut or the like to move the or each jaw. The or each jaw is preferably movable in a slot or other guiding means which may guide its transverse movement and may advantageously be integral with the casing. The casing preferably has at least one sealing material containment cavity, for example to contain sealing material which forms a seal, in use, between the casing and one or more cables extending longitudinally into the casing, the cavity preferably being bounded, at least in use, at one of its longitudinal extremities by a transverse wall within the casing and at the other of its longitudinal extremities by the, or at least one of the, cable grippers. The sealing material preferably comprises gel and/or mastic. The casing is preferably longitudinally divided, more preferably comprising longitudinally separable half-shells.

The invention will now be described, by way of example, with reference to the accompanying drawings, of which:

Figure 1 (a to e) shows, schematically, the steps involved in installing a cable splice closure according to the invention around a cable splice;

Figure 2 (a and b) shows the two half-shells of a preferred form of casing of a closure according to the invention;

Figure 3 (a to e) shows several views of a preferred form of cable gripper according to the invention;

Figure 4 (a to c) shows some additional views of the cable gripper shown in Figure 3;

Figure 5 (a to c) shows some views of another form of cable gripper according to the invention;

Figure 6 (a to d) shows some views of a further form of cable gripper according to the invention

Figure 7 (a and b) shows, schematically, how a cable gripper, adjustment devices and casing of a closure according to the invention inter-relate;

Figure 8 (a and b) shows, in part schematically, a cable gripper according to the invention which has a plurality of attachable and removable parts;

Figure 9 shows another cable gripper according to the invention;

Figure 10 shows a cable gripper according to the invention, which has a pivoted part;

Figure 11 shows, schematically, how a preferred fastening means for fastening together two parts of a cable splice closure according to the invention is used;

Figure 12 (a and b) shows part of a closure according to the invention which has centrally (in the transverse direction) positioned tightening means;

Figure 13 (a and b) shows two further views of the closure shown in Figure 12;

Figure 14 is a schematic view of a closure which has centrally positioned tightening means;

Figure 15 (a to f) is six different schematic views illustrating a range of cable arrangements accommodated by closures according to the invention;

Figure 16 (a and b) shows two views of a preferred jaw of a closure according to the invention;

Figure 17 (a to c) shows parts of three jaws of closures according to the invention; and

Figure 18 is a schematic view showing the working arrangement of jaws as shown in Figure 17b and 17c.

Drawings a to e of Figure 1 show, schematically, the steps involved in installing a cable splice closure according to the invention around a cable splice. Figure 1a shows a splice 1 between two cables (e.g. electrical or telecommunications cables) 3. In Figure 1b, two blocks 5 of sealing material have been added to the cables 3, one block being located at each longitudinal extremity of the splice 1. These sealing blocks 5 are preferably formed by spirally wrapping strips of sealing material around the cables 3. The sealing material preferably comprises gel and/or mastic.

In Figure 1c, two cable grippers 7 are shown, schematically, positioned around the cables 3, each cable gripper being located adjacent to a respective sealing block 5, on the opposite side of the sealing block to the splice 1. Each cable gripper 7 comprises two jaws 9 which can cooperate to grip the cable 3 between them. Each cable gripper 7 will normally have two elongate tightening means, but for clarity these are omitted from Figure 1. Some preferred forms of cable gripper are shown in more detail in figures 3 to 6.

Figure 1d shows, schematically, two half-shells 11 of a casing arranged on either side of the splice of Figure 1c. Each casing half-shell 11 has a slot 13 at each longitudinal end thereof, into which a jaw 9 of a respective cable gripper 7 may be located. In use, when the two half-shells 11 are brought together, thereby closing the casing around the splice 1 (as shown in Figure 1e), each cable gripper 7 is located in a closed slot formed by the joining of two opposing slots 13 in each of the half-shells. The slots serve to guide the transverse movement of the jaws 9 with respect to the casing and to position correctly the cable grippers 7 with respect to the cables 3 and splice 1. The slots 13 are integrally formed, e.g. moulded, with the casing. Each slot 13 in the half-shells 11 has an opening 21 communicating between the slot and the exterior of the casing. Each opening 21 permits an tightening means, e.g. a bolt or the like, to extend from the interior to the exterior of the casing, so that a respective jaw 9 may be moved by means of the tightening means from the exterior of the casing.

Each half-shell 11 of Figure 1d also contains a sealing material containment cavity 15 towards each longitudinal end thereof, inwardly of a respective slot 13. The inner longitudinal extremity of each sealing material containment cavity 15 is bounded by a transverse wall 17. In use, each cable gripper 7 forms the outer longitudinal boundary of its respective cavity 15. When the half-shells 11 are brought together, closing the casing, each sealing material block 5 is located in a respective sealing material containment cavity 15, and preferably the fastening together of the half-shells 11 causes the sealing material to be compressed in the cavity. This can often help to enhance the effectiveness of the sealing material. At least one of the two

half-shells has two longitudinal seals 19, which are preferably, but not necessarily, formed from the same sealing material as the sealing blocks 5. The longitudinal seals 19 form seals along at least most of the length of the casing between the opposing edges of the two half-shells 11. Preferably, each longitudinal seal comprises sealing material located in a channel along each longitudinal edge of at least one of the half-shells. Advantageously, the longitudinal seals 19 may be arranged to be in sealing contact with the sealing blocks 5 when the casing is closed. This may be achieved, for example, by providing gaps in an inner wall of the casing which communicate between the interior wall of the casing and the longitudinal channel in which the longitudinal seal is located.

The two half-shells 11 may be fastened together by means of a series of bolts or the like, or by means of other fastening means, along the longitudinal flanges of the casing.

Figure 2 (a and b) shows another preferred form of casing of a cable splice closure according to the invention. This casing is very similar to the casing shown in Figure 1, except that the sealing material containment cavities of this casing are much less pronounced than those in the casing of Figure 1. This is because the transverse wall of each cavity comprises a shallow step 23 extending around the interior of the casing, rather than a wall extending across the interior of the casing as in Figure 1. In substantially every other respect, however, the casing shown in Figure 2 is substantially the same as that shown in Figure 1, and corresponding parts of both casings are given the same reference numerals.

Figure 3 (a to e) shows several views of a preferred form of cable gripper 7 according to the invention. The cable gripper 7 comprises two jaws 9 between which a cable can be gripped, each jaw having a gripping surface 25 which grips the cable(s). The two jaws 9 are interconnected by means of two elongate tightening means 27 in the form of screw-threaded bolts. Each jaw has, at one transverse end, a female screw-threaded portion 29 into which one tightening means 27 is screwed, and

at the other transverse end a hollow guide portions 31 (which is not screw-threaded) through which the other tightening means 27 freely extends. Figure 3a shows the jaws 9 and the tightening means 27 separate prior to the cable gripper being assembled. In Figure 3b, the tightening means 27 are shown extending through their respective guide portions 31 and partially screwed into their respective screw threaded portions 29. If the tightening means are screwed further into their respective screw threaded portions 29, the jaws will be pulled towards each other, and if one or more cables are positioned between the jaws 9, the cables will be gripped between the two gripping surfaces 25. Figure 3c shows a fully tightened cable gripper 7, in which the two jaws 9 are at their closest possible relative position. In use, each tightening means 27 preferably extends from the exterior to the interior of a cable splice closure casing, through an opening in the casing. The two jaws 9 of each cable gripper 7 are preferably slidably connected together, for example by portion 29 sliding in portion 31. The two jaws can be substantially identical to each other (as shown), or mirror images of each other, for example. Each jaw may have one groove and one rail adapted to cooperate with a respective groove and rail of the other jaw, or one jaw may have two grooves, and the other jaw may have two rails, for example.

The gripping surfaces 25 of the cable gripper shown in Figure 3 are profiled to enhance their grip on the cables. The profiling comprises a series of alternating ridges and troughs which extend transversely across each gripping surface 25.

Drawings 3d and 3e illustrate the ranges of cable sizes and numbers of cables which preferred cable grippers can grip. Drawing 3d shows four large diameter cables in the cable gripper and Drawing 3e shows a single small diameter cable in the cable gripper.

Figure 4 (a to c) shows some additional views of the cable gripper shown in Figure 3.

Figures 5 and 6 show some views of two additional forms of a cable gripper according to the invention.

Figure 7 (a and b) shows, schematically, how a cable gripper, tightening means and casing of a closure according to the invention inter-relate. Figure 7a shows a casing 33, comprising two half-shells, a screw-threaded tightening means 27 and a jaw 9 of a cable gripper. The casing 33 contains openings 35 communicating between the interior and the exterior of the casing, to allow a respective tightening means to extend therethrough. From Drawing 7b, it can be seen that tightening upper tightening means 27' raises lower jaw 9' and that tightening lower tightening means 27" lowers upper jaw 9". This is because the guide portions 31 are not screw threaded, and hence the tightening means 27 freely extend through the guide portions 31, whereas they are screwed into the portions 29. It will also be appreciated that if a cable extends between the jaws 9, tightening the tightening means may cause the two half-shells of the casing 33 to be moved together, closing the casing.

Figure 8a shows a cable gripper jaw 9 according to the invention, which has a plurality of attachable and removable parts 37 which can be attached to, and removed from the jaw 9 in order to select a particular jaw configuration corresponding to the number and/or arrangement of cables to be gripped. It can be seen that the parts 37 can slot into the jaw 9, and that each part has a uniquely shaped gripping surface 39. Figure 8b shows, schematically, a range of sizes and numbers of cables 3 and a range of parts 37 which may be selected to grip such cables 3 in an optimum way.

Part 39' in Figure 8a is adapted to be located between two cables or two sets of cables which are such that it divides the cables in a direction substantially perpendicular to the direction in which a pair of jaws 9 (shown schematically in Figure 8a) move relative to each other in use. Figure 9 shows another form of cable dividing part 37' which may be slotted between a pair of jaws 9. This part 37' has transverse extensions 41 which help to locate it in the jaws 9.

Figure 10 shows a jaw 9 of a cable gripper according to the invention which has a pivoted part 43, which is pivoted with respect to the remainder of the jaw about point 45. This form of cable gripper has the advantage that the pivoted part 43 automatically pivots to adopt the optimum orientation for gripping one or more cables when the jaw is moved into gripping contact with the cables in use. It can normally, therefore, accommodate a range of sizes and numbers of cables, and can advantageously grip each configuration of cables equally, or substantially equally, well. Instead of being simply pivoted, the part 43 could advantageously be jointed with respect to the remainder of the jaw in other ways, for example by means of a universal joint.

Figure 11 shows schematically, how a preferred fastening means in the form of an elongate fastening member (e.g. a rod) 47 may be used to fasten together two parts 49 and 51, e.g. half-shells, of a casing of a cable splice closure according to the invention. As shown, the elongate member 47 extends through cooperating parts 53 on the two casing parts. Many other ways of closing the casing (e.g. by fastening together two or more parts) may be used, as explained above.

Figure 12a shows a cross-sectional view, and Figure 12b shows a perspective cross-sectional view, of part of a cable splice closure according to the invention which has tightening means 27 which are arranged centrally with respect to the jaws 9 (in the transverse direction). The two tightening means 27 (in the form of screws) are each located in the same central position in the transverse direction, but are spaced apart from each other in the longitudinal direction. Tightening the upper screw 27 (as drawn) raises the lower jaw 9 (as drawn) and tightening the lower screw 27 (as drawn) lowers the upper jaw 9 (as drawn). Two further views of the jaws 9 and tightening means 27 are shown in Figure 13 (a and b). Figure 13a shows the jaws 9 tightened around a large diameter cable L and a small diameter cable S. The jaws 9 have each pivoted about a longitudinal axis extending through each tightening means 27, in order to adopt the optimum orientation for gripping the two cables.

Figure 14 shows a schematic view of jaws 9 having centrally positioned tightening means 27 and closed half-shells 11 of a casing. Figure 15 a to f shows six schematic views similar to that of Figure 14, illustrating a range of cable arrangements (with small (S), medium (M) and large (L) diameter cables) accommodated by closures according to the invention. In views d, e and f, an intervening jaw piece 55 is provided, thereby effectively converting one pair of jaws into two pairs of jaws, and allowing two "layers" of cables to be accommodated.

Figure 16a shows a preferred form of jaw 9 which, in use, has centrally positioned tightening means. In Figure 16b, the jaw is shown partially cut away. The jaw has two concave portions 57 (also illustrated in Figure 14) for receiving cables. These concave portions 57 have teeth 59 for enhancing the grip of the jaw on the cables. (These teeth are also shown in Figures 12a and 14). The jaw 9 may be pivoted, in use, about a pin 61 which is rotationally mounted therein, and which extends longitudinally (with respect to the direction in which the cable(s) extend in use) therethrough. The pin 61 has a female screw thread 63 for threaded engagement with a threaded tightening means and a non-threaded hole 65 to allow another tightening means to extend freely therethrough.

Figure 17a to c shows three partially cut away views of jaws which are similar to that shown in Figure 16. In views 17b and 17c, the pins 61 extend only approximately half way (in the longitudinal direction) across the jaw, thereby avoiding having to provide a hole 65 therethrough. The working arrangement of the jaws shown in views 17b and 17c is shown schematically in Figure 18.

Claims

1. A cable splice closure, comprising:

(a) a casing which can be closed around a cable splice; and

(b) one or more cable grippers which can be operated from the exterior of the casing.

2. A cable splice closure, comprising:

(a) a casing which comprises first and second parts which can be brought together to close the casing around a cable splice;

(b) one or more cable grippers; and

(c) tightening means which, in use, at least contribute(s) to bringing together, and preferably to fastening together, the first and second casing parts, and which cause(s) the or each cable gripper to grip a cable extending, in use, into the casing, preferably as the first and second parts are brought together.

3. A cable splice closure according to claim 1 or claim 2, in which the or each cable gripper comprises at least one jaw which, in order to grip a cable extending, in use, into the casing, can be moved with respect to the casing by means of tightening means which can be operated from the exterior of the casing when the casing is closed in use.

4. A cable splice closure according to claim 2 or claim 3, in which the or each tightening means locates at least one said cable gripper, preferably in a floating manner, inside the casing.

5. A cable splice closure according to claim 4, in which the or each jaw can be moved, by means of at least one said tightening means, with respect to the casing in a direction substantially transverse to the cable.

6. A closure according to claim 4 or claim 5, in which, in order to grip a cable extending into the closure, the or each jaw of the or each cable gripper may be pulled towards the cable by means of at least one said tightening means.

7. A closure according to any one of claims 4 to 6, in which the or each cable gripper comprises two said jaws between which a cable can be gripped, and which can be moved with respect to each other in a direction substantially transverse to the cable when, in use, it extends into the casing.

8. A closure according to any one of claims 4 to 7, in which at least part of the or each jaw automatically adopts an optimum orientation, with respect to one or more cables extending into the casing, for gripping the cable(s), when the jaw is moved into gripping contact with the cable(s) in use.

9. A closure according to claim 8, in which part of the or each jaw is pivoted with respect to the remainder of the jaw, and the pivoted part automatically pivots to adopt the optimum orientation for gripping the cable(s) when the jaw is moved into gripping contact with one or more cable(s) in use.

10. A closure according to any one of claims 4 to 9, in which the or each jaw has one or more part(s) which can be attached thereto or removed therefrom in order to select a particular jaw configuration corresponding to the number and/or arrangement of cables to be gripped.

11. A closure according to any preceding claim, in which the or each cable gripper is situated inside the casing when the casing is closed in use.

12. A closure according to any one of claims 2 to 11, in which the or each tightening means is elongate and extends from the interior to the exterior of the casing.

13. A closure according to any one of claims 2 to12, in which the or each tightening means is screw threaded, and the tightening means and/or a nut threaded onto the tightening means may be screwed with respect to the casing in order to move a jaw of a cable gripper with respect to the casing.

14. A closure according to one of claims 5 to 13, in which the casing includes guiding means which guide(s) the said transverse movement of the or each jaw.

15. A closure according to claim 14, in which the or each guiding means comprises a slot.

16. A closure according to claim 15, in which the or each slot is integral with the casing.

17. A closure according to any preceding claim, in which the casing has at least one sealing material containment cavity, to contain sealing material which forms a seal, in use, between the casing and one or more cables extending longitudinally into the casing, the or each cavity being bounded, at least in use, at one of its longitudinal extremities by a transverse wall within the casing and at the other of its longitudinal extremities by the, or at least one of the, cable grippers.

18. A cable splice closure, comprising a casing which can be closed around a cable splice, and one or more cable grippers, the or each cable gripper comprising at least one jaw which, in order to grip a cable extending, in use, into the casing, can be moved with respect to the casing in a direction substantially transverse to the cable, the or each jaw being movable in guiding means integral with the casing and which guide(s) the said transverse movement of the or each jaw.

19. A closure according to claim 18, in which the or each guiding means comprises a slot.

20. A closure according to claim 18 or claim 19, in which the or each jaw can be moved by means of tightening means.

21. A closure according to any one of claims 18 to 20, in which the casing has at least one sealing material containment cavity, to contain sealing material which forms a seal, in use, between the casing and one or more cables extending longitudinally into the casing, the or each cavity being bounded, at least in use, at one of its longitudinal extremities by a transverse wall within the casing and at the other of its longitudinal extremities by the, or at least one of the, cable grippers.

22. A cable splice closure, comprising a casing which can be closed around a cable splice, and one or more cable grippers, the casing having a sealing material containment cavity, to contain sealing material which forms a seal, in use, between the casing and one or more cables extending longitudinally into the casing, the or each cavity being bounded, at least in use, at one of its longitudinal extremities by a transverse wall within the casing and at the other of its longitudinal extremities by the, or at least one of the, cable grippers.

23. A closure according to claim 22, in which the or each cable gripper comprises at least on jaw which, in order to grip a cable extending, in use, into the casing, can be moved with respect to the casing in a direction substantially transverse, preferably substantially perpendicular, to the cable.

24. A closure according to claim 23, in which the or each jaw can be moved by means of tightening means.

25. A closure according to claim 23 or claim 24, in which the casing includes guiding means which guide(s) the said transverse movement of the or each jaw.

25. A closure according to claim 25, in which the or each guiding means comprises a slot.

26. A cable gripper, comprising at least one jaw, preferably two jaws, which can be moved into gripping contact with one or more cables, the jaw, or at least one of the jaws, having a part which, when the jaw is moved into gripping contact with one or more cable(s) in use, automatically adopts an optimum orientation, with respect to one or more cables, for gripping the cable(s).

27. A cable gripper according to claim 26, in which part of the or each jaw is pivoted with respect to the remainder of the jaw, and the pivoted part automatically pivots to adopt the optimum orientation for gripping the cable(s) when the jaw is moved into gripping contact with one or more cable(s) in use.

Fig.1a.

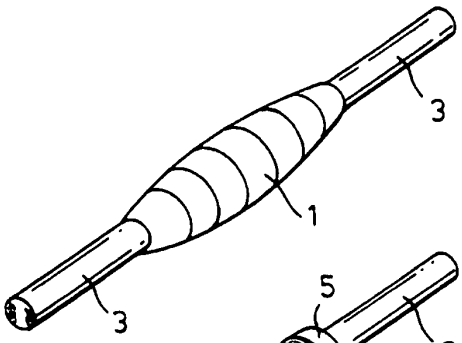


Fig.1b.

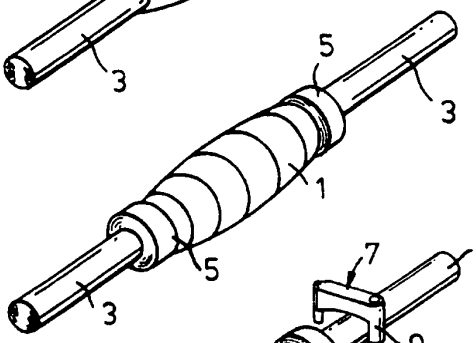


Fig.1c.

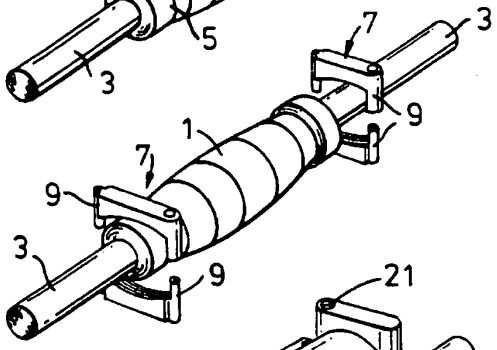


Fig.1d.

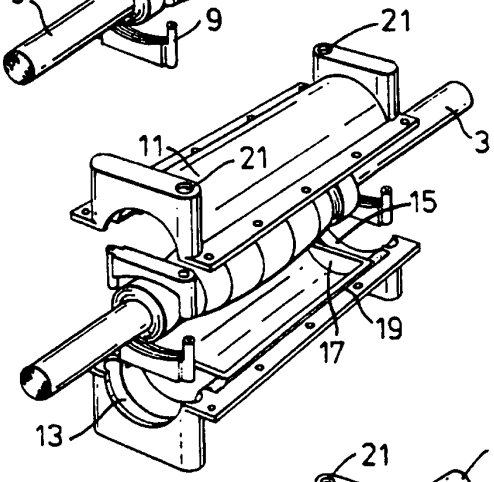


Fig.1e.

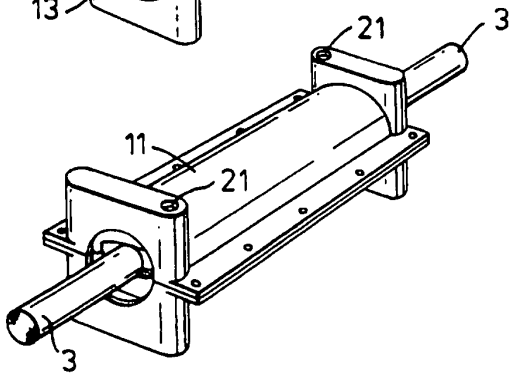


Fig.2a.

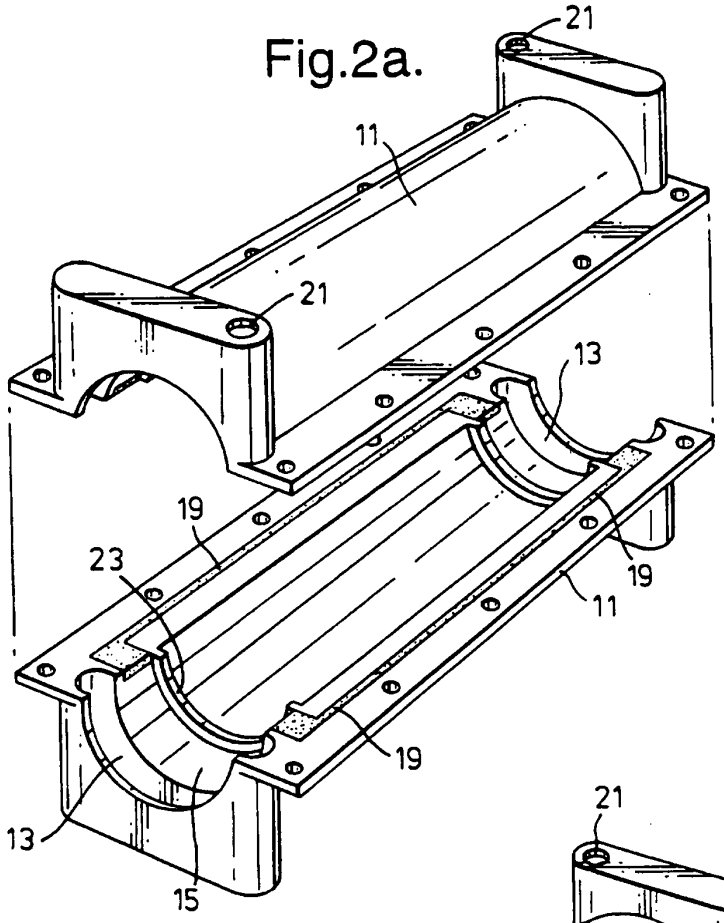


Fig.2b.

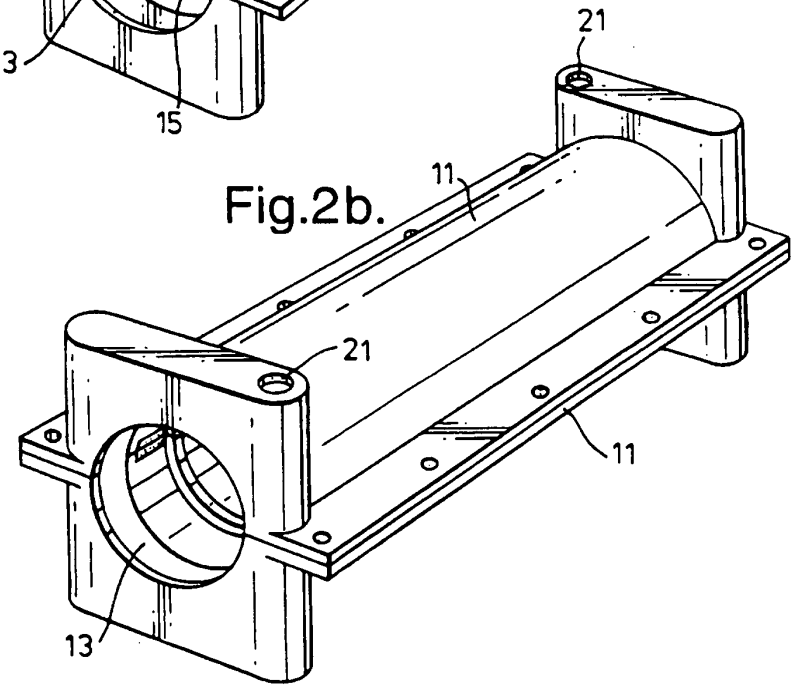


Fig.3a.

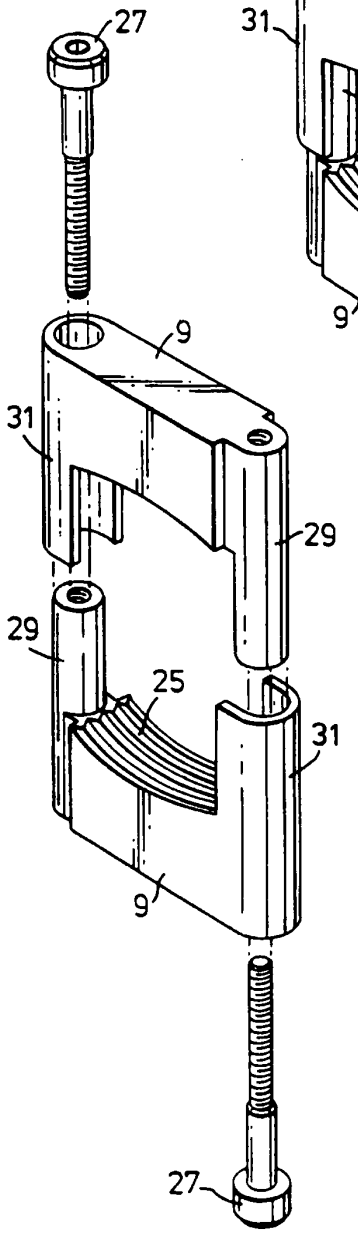


Fig.3b.

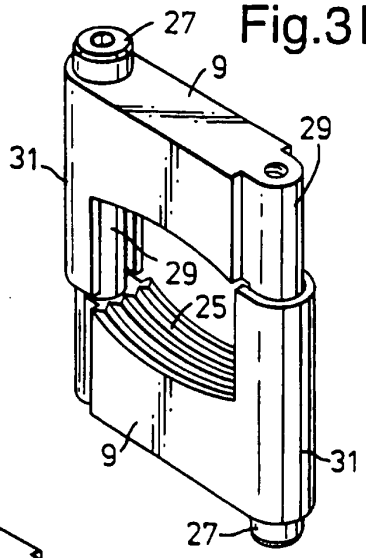


Fig.3c.

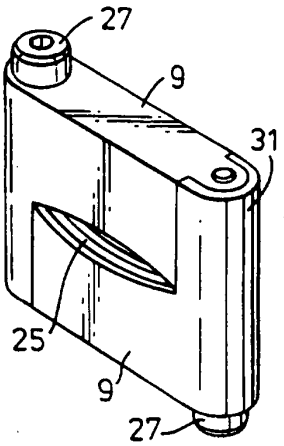


Fig.3d.

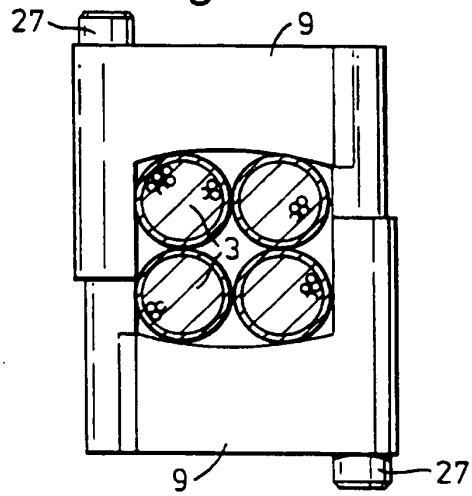
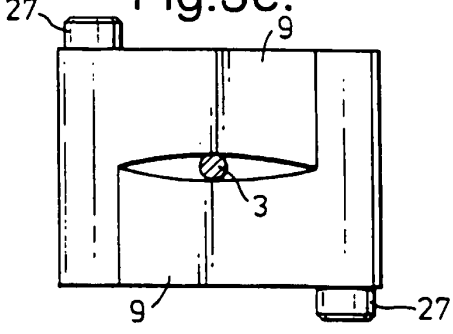


Fig.3e.



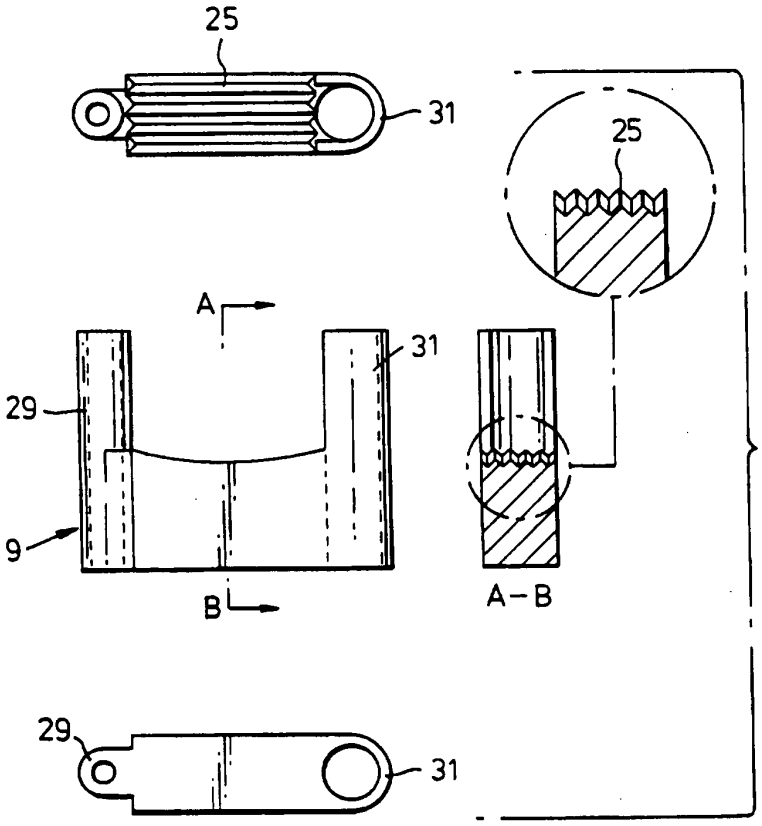


Fig.4a.

Fig.4b.

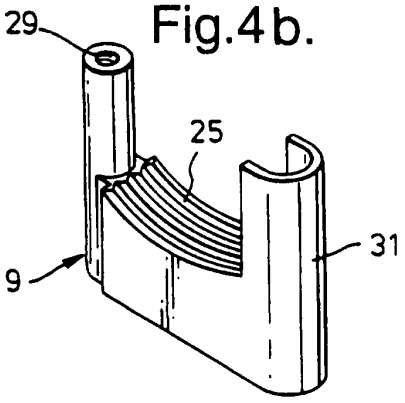


Fig.4c.

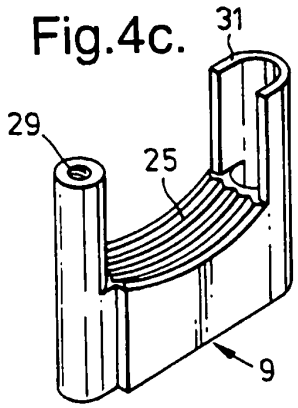


Fig.5.

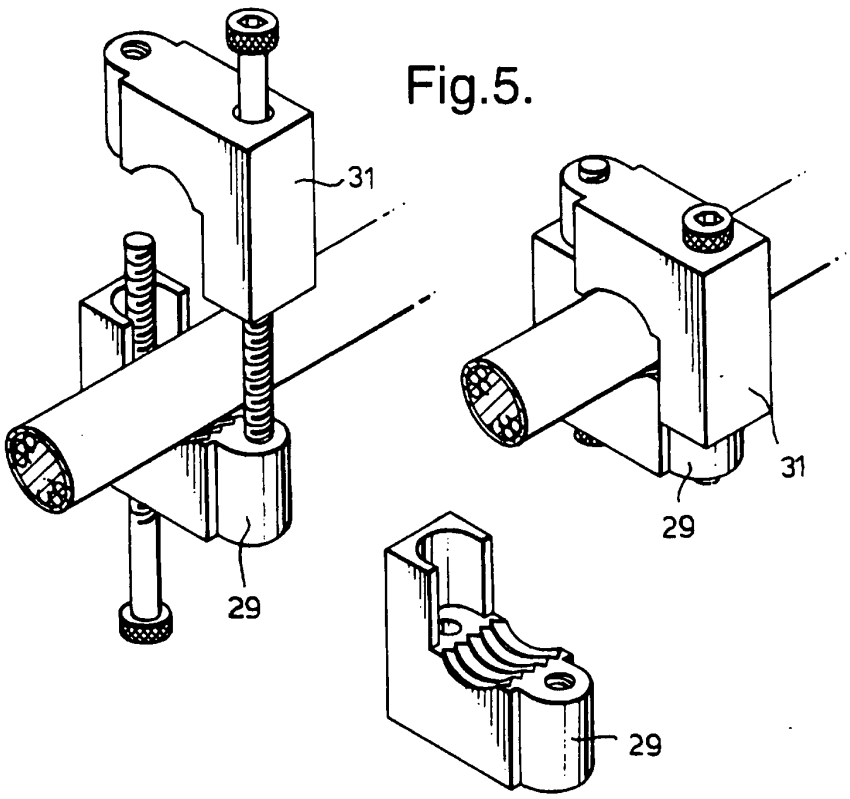


Fig.7 a.

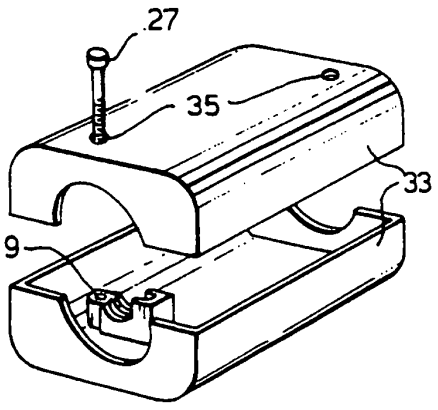


Fig.7b.

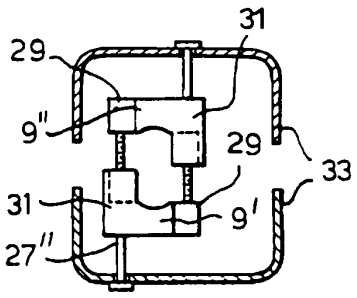


Fig.6.

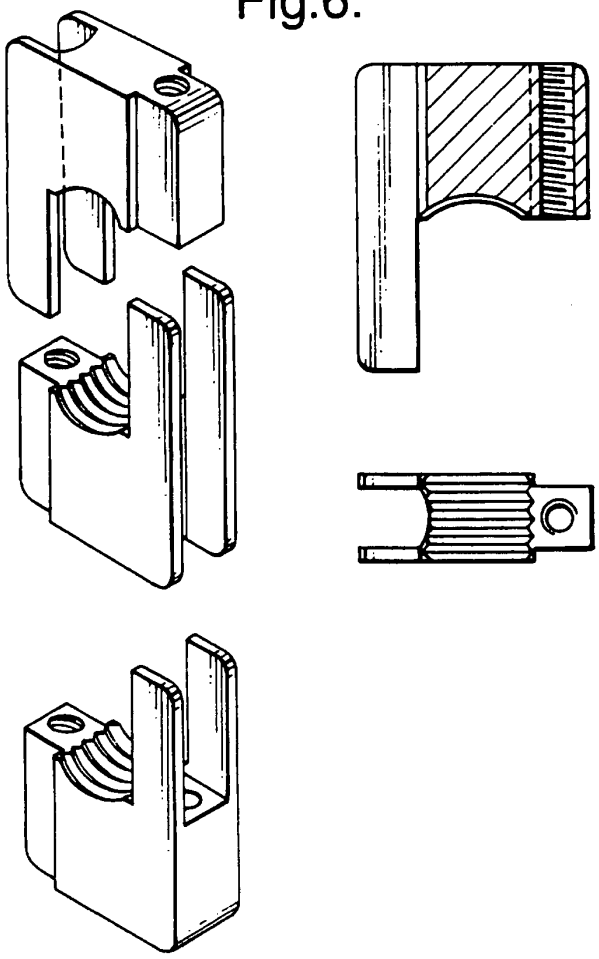


Fig.10.

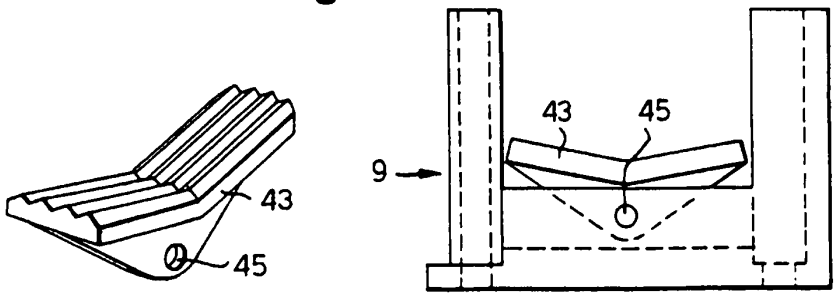


Fig.8a.

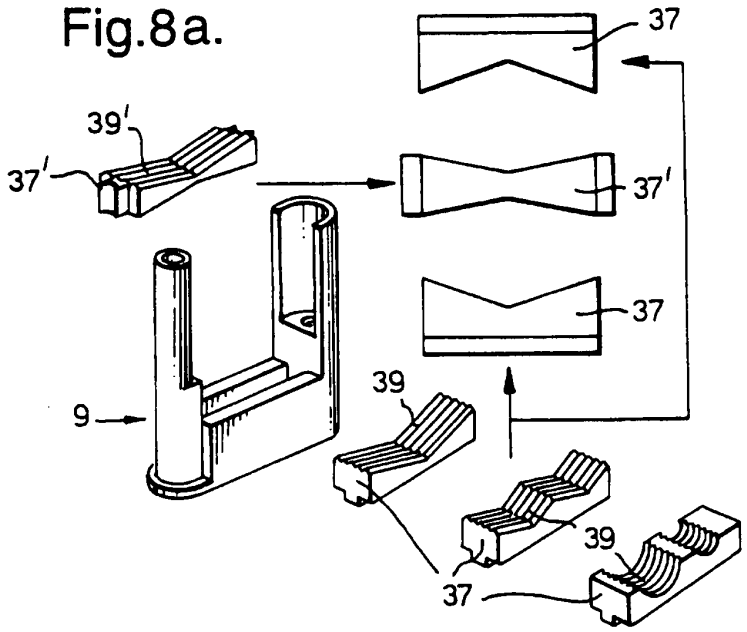


Fig.8b.

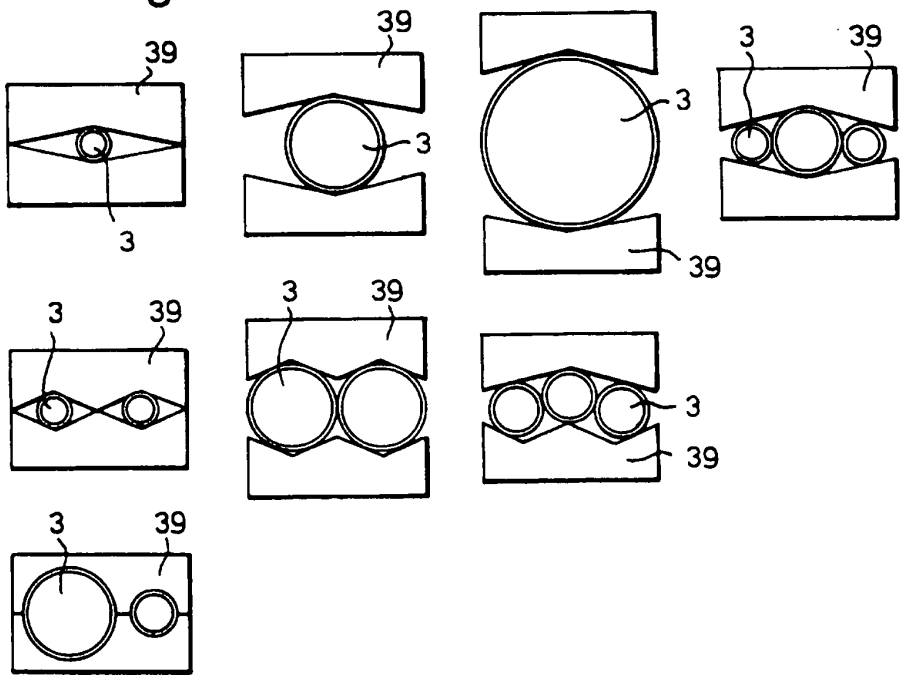
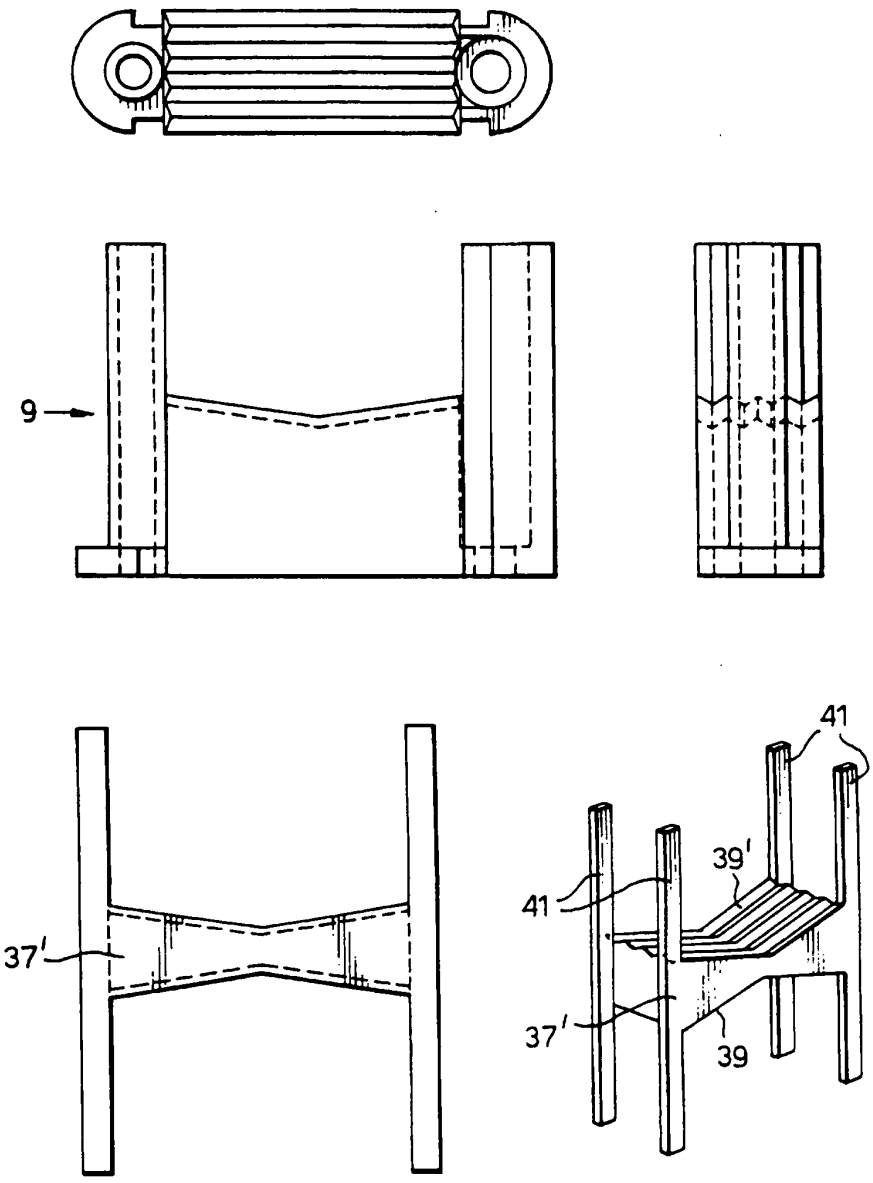


Fig.9.



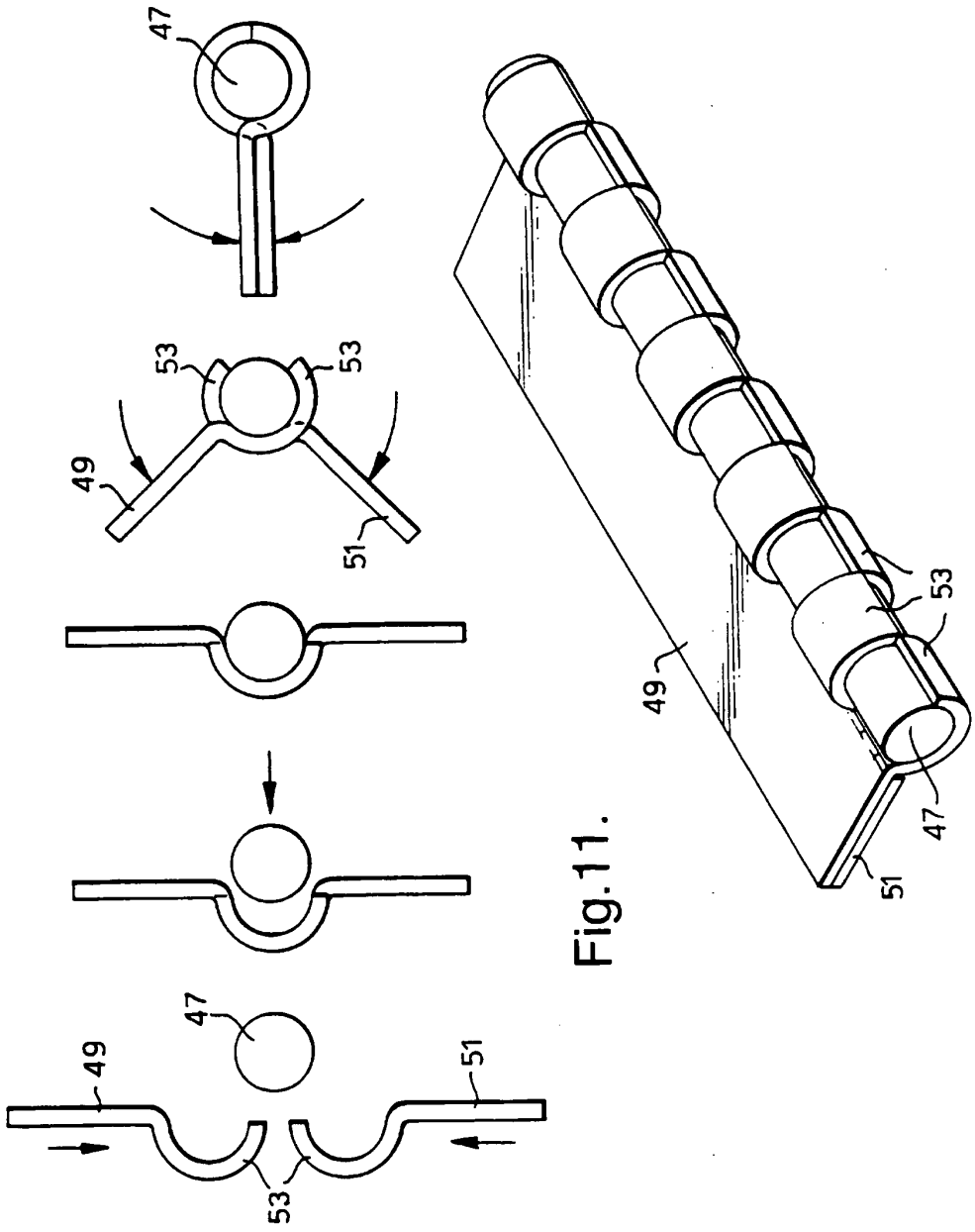


Fig.11.

Fig.12a.

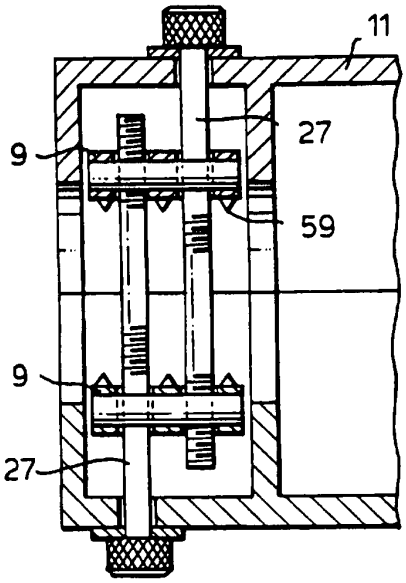


Fig.12b.

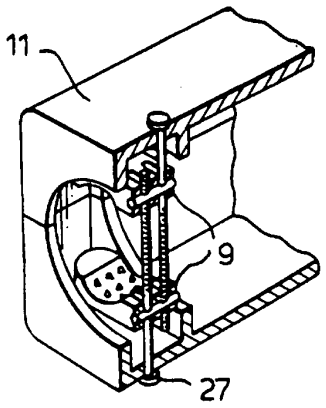


Fig.13a.

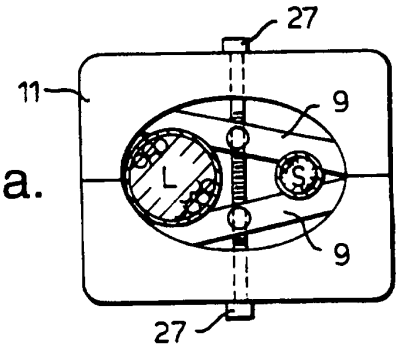


Fig.13b.

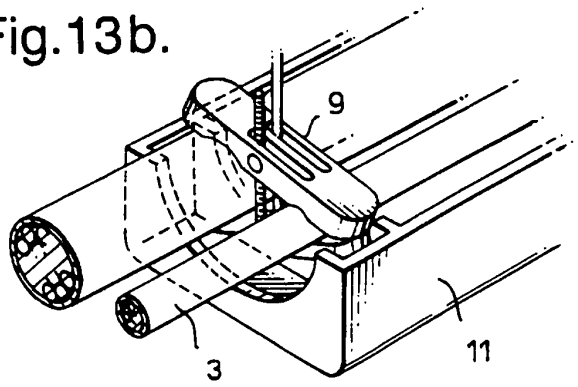


Fig.14.

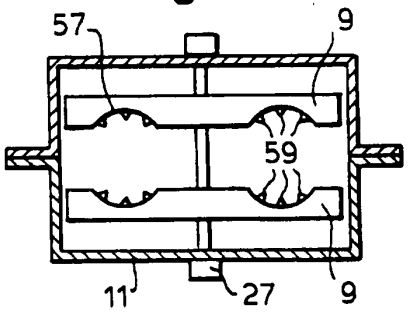


Fig.15a.

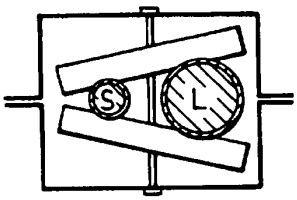


Fig.15b.

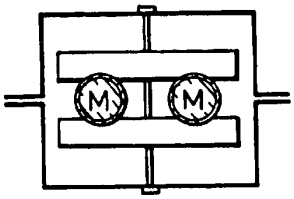


Fig.15c.

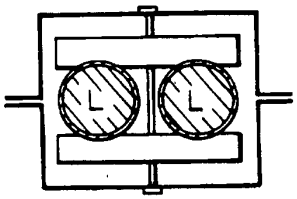


Fig.15d.

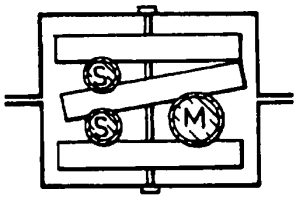


Fig.15e.

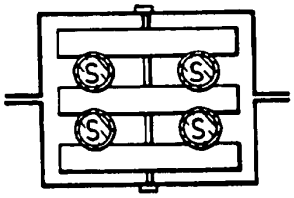


Fig.15f.

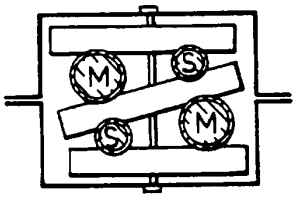


Fig.16a.

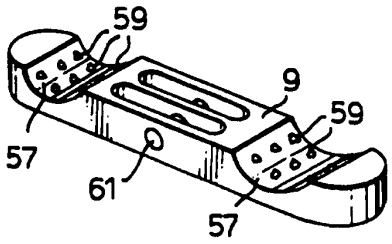


Fig.16b.

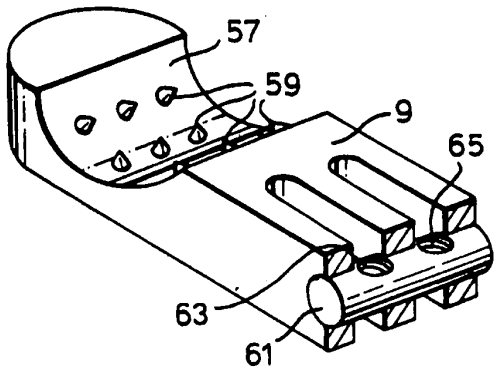


Fig.17a.

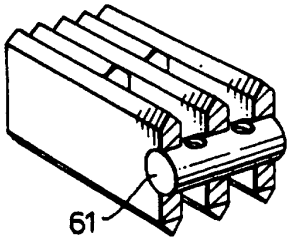


Fig.17b.

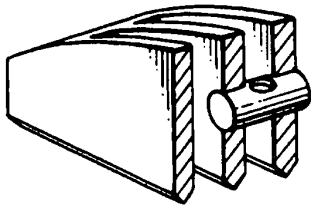


Fig.17c.

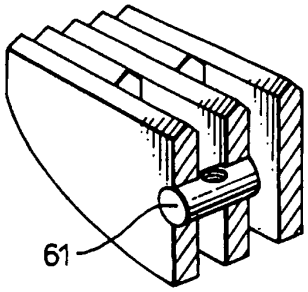
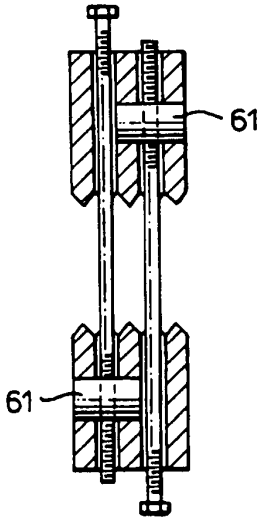


Fig.18.



INTERNATIONAL SEARCH REPORT

Intern al Application No
PCT/GB 96/00194

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H02G15/007 H02G15/013

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H02G H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	EP,A,0 316 911 (NIPPON TELEGRAPH AND TELEPHONE) 24 May 1989 cited in the application see column 7, line 30 - column 8, line 25; figures 2,4,5	1 3-7,11, 13,14, 18,20, 23-25
Y	US,A,3 112 148 (WOCHNER) 26 November 1963 see column 4, line 60 - line 68; figures 1,2,4	1
A	US,A,4 295 005 (DAUGHERTY ET AL.) 13 October 1981 cited in the application see abstract; claim 1; figures 1-5	1

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 April 1996	08. 05. 96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Lommel, A

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INTERNATIONAL SEARCH REPORT

Intern al Application No
PCT/GB 96/00194

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,4 341 922 (BOSSARD ET AL.) 27 July 1982 cited in the application see abstract; claim 1; figures 1-3	1
A	FR,A,1 113 074 (C.D.L.) 23 March 1956 see page 1, right-hand column, line 13 - line 33; figures 1-3	1,3-7, 11,13, 18,20, 23,24
A	GB,A,259 587 (JERIKE) 6 February 1928 see claim 1; figures 4,9,14,17	1,3-7, 11,13, 18,20, 23,24

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter ial Application No
PCT/GB 96/00194

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		JP-A-	1135902	29-05-89
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		EP-A,B	0023099	28-01-81
		JP-A-	56019326	24-02-81
FR-A-1113074	23-03-56	NONE		
GB-A-259587		NONE		